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ECHINACEA ROOTS.

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Read before the Academy, at Manhattan, November 27, 1903.

SOME few years ago a report was made to this Academy under the head of "Kansas Medicinal Plants," which referred to echinacea root. It was then stated that large quantities of it were gathered in different parts of the state of Kansas and in some other sections of the Western country. Reference was also made to the growing importance of this root as a medicinal drug. This report, as far as we know, was never published in the proceedings. At this time we will review in brief what was said at that time, and will give a report which relates to the further developments in connection with the commercial aspect of the *Echinacea* and will incorporate some results of chemical examination.

We have in the state of Kansas two species of echinacea root. One is known as *Echinacea purpurea* and the other *Echinacea angustifolia*.

1. *Echinacea purpurea*. Leaves rough, often serrate; the lowest ovate, five-nerved, veiny, long-petioled; the others ovate-lanceolate; the involucle imbricated in three to five rows; stem smooth or in one form rough-bristly, as well as the leaves. Rays fifteen to twenty, dull purple (rarely whitish), one to two inches long or more. Root thick, black, very pungent to the taste.

2. *Echinacea angustifolia*. Leaves, as well as the simple slender stem, bristly-hairy, lanceolate and linear-lanceolate, alternate at the base, three-nerved, entire; involucle less imbricated and heads often smaller; rays twelve to fifteen, two inches long, rose color or red.

The root of the *angustifolia* species is the one which is in demand as a medicinal drug, although it is a question whether the *purpurea* does not have similar properties. Judging from its gross characteristics, one would suppose that the latter had similar medicinal action to the former.

The common names of the plant in the state are: Nigger-head, hedgehog, cone-flower, and black susans. One of these appellations, the "hedgehog," as also the botanical name, "*Echinacea*" (*echinos*, spiny), are derived from the physical features of the plant, the fruiting head being spiny.

Echinacea root, when dry, has a brownish-black color, longitudinally wrinkled and twisted, the epidermis frequently shrunken. In cross-section, the wood wedges are seen to be of a gray color, and the inter-

venering parenchymatous tissue (medullary rays) is colored dark gray, or grayish-black, due to the infiltrated coloring matter. The fracture is short and rough; the taste is peculiar, biting, somewhat acrid, producing a sensation slightly reminding one of pyrethrum; the odor—more prominent in concentrated preparations—cannot be compared to that of any other substance; it has a somewhat musty or mousey odor, accompanied with a peculiar pungency.

We have chemically examined each in the laboratory, and find the following constituents:

Chloroform extract	1.353
Petroleum ether extract.....	1.32
Benzole extract.....	2.025
(a) Soluble in alcohol.....	87.66
(b) Insoluble residue	12.34
Ether extract.....	2.12
(a) Soluble in water.....	18.95
(b) Soluble in alcohol.....	57.87
(1) Soluble in carbon disulphide.....	50.12
(2) Soluble in benzene	18.98
(3) Residue (insoluble in dilute acids).....	30.90
(c) Insoluble residue	23.19
Alcoholic extract	12.078
(a) Resin	9.78
(b) Vegetable acids.....	38.62
(c) Coloring matter.....	51.58
Aqueous extract.....	9.744
(a) Gum	32.33
(b) Carbohydrates.....	18.95
(c) Undetermined residue.....	51.28
Soda extract.....	20.026
(a) Albuminoids	13.36
(b) Undetermined residue.....	86.64

CARBON DISULPHIDE EXTRACT.—It was found by the preliminary analysis that, among the various solvents used, carbon disulphide would be the most promising as the one which might yield the activities of the drug and leave behind in the extraction apparatus the largest percentage of inert and coloring matter. Acting upon this, it was found that our predictions were correct, as will be seen from the following: Fifty grams of the powdered root were introduced into a Soxhlet apparatus, and by continuous percolation for eight hours was thoroughly extracted by this solvent. After slowly evaporating the tincture spontaneously, and when the concentrate reached a small bulk, acicular crystals appeared. These were large and well defined. When the liquid was concentrated to a semi-solid, under the microscope it could be well intermixed with the large acicular crystals and small sheafs and rosettes. These were suspended in a brownish, somewhat sirupy liquid. The crop of crystals was quite abundant, almost entirely

solidifying the entire mass. The crystalline mass as contained in the sirupy evaporate had an odor and taste characteristic of the drug, but very much intensified. It was believed that the active principle or principles were contained within this concentrate, but when the crystals were purified they proved to be of a fatty character. The pungency and acridity seem to reside in an oleo-resinous compound, which we have not had the opportunity to study in detail as yet. The acridity of the crystals was due probably to adhering resin. Alcohol dissolved the crystals very sparingly indeed; chloroform affected them somewhat; ether had some effect; but carbon disulphide dissolved them immediately, from which solution on evaporation the acicular and sheath-like crystals reformed. A few of them were placed on a platinum foil and heated over a Bunsen flame. At first they fused into a globular form. A continued heat carbonized the mass, which evolved grayish-brown fumes. On continuous heating the whole disappeared from the platinum foil. We regret that time has not allowed a chemical examination of these crystals and that a further report on them must be deferred. Our impression is that these crystals are composed of fatty matter in which is dissolved a considerable amount of the acrid principle.

Quite recently much interest has been manifested in echinacea from an economic point of view. On October 12 last a representative of a large manufacturing house in Cleveland, Ohio, was sent to me to assist him in the study of the source of echinacea, and to assist him in collecting it. To my surprise, I found the house he represented desired 40,000 pounds of the drug. About three weeks later another Eastern house sent to me, asking that I might assist them in obtaining collectors who might supply 20,000 pounds. Numerous other smaller demands have been made from the various drug houses and manufacturers for large quantities, such as 100-pound or 200-pound lots. We mention this merely to show to what extent the demand for echinacea has grown in the past few years, and also to show what economic value the plant has become to the state. It is safe to say that in one year it has brought to the state over \$100,000, as over 200,000 pounds have been collected, and it has brought at times as much as fifty cents per pound. In view of this fact, that the demand was so great as to injure the source of supply, we wrote to the Department of Agriculture, at Washington, D. C., to Rodney H. True, who is in charge of the drug and medical-plant investigation, asking that something be done by the government for the protection of this weed against extermination. Mr. True replied that the matter of cultivating the weed had suggested itself to him, but he was not aware of the shortage of the plant, as I had represented it. Under the circumstances, he said he would be very glad to study the habits of the

plant, and for that purpose would like to obtain seeds or living roots for such purpose, and for these and for information and help in this matter he was recommended to address Professor Roberts, of the Agricultural College.

On November 9 I received a letter from the house in Cleveland, in reply to a letter from me asking for information regarding the results of their investigation on the habits of the plant, etc. Their reply stated that their agent found it growing pretty well all over the state of Kansas, but that it is only gathered in commercial quantities in the northwestern part of the state. The reason for this seems to be, that the root thrives better in the rocky soil of that district. They further stated: "We think that your suggestion on the cultivation of the root would prove of benefit to the drug trade as well as to the farmers of Kansas." This writer found two objections to this cultivation, one being that it takes five years for the plant to come to maturity. This makes a very slow crop. And, secondly, that when grown on rich soil, suitable for cultivation, the root never becomes large enough in size to pay for digging it—never becomes larger than a lead-pencil, and strikes right down in the earth. In the rocky soil where it is gathered, most of the root becomes large in diameter, and is easily gathered in quantities by aid of a pick.

As an appendix to the above, we wish to say that a contrary opinion is held by W. H. Baker, of Manhattan, formerly of Topeka, as to the kind of soil suitable for growing *Echinacea angustifolia*. He states that, from his observation of the habits and growth of it, he is led to believe that the plant can be grown in ordinary garden soil. In Jefferson county, three miles east of Grantville, he saw the plant growing in abundance on a rich upland meadow that was slightly sandy. Jefferson county is among the eastern tier of counties. In one-half day, in this meadow, Mr. Baker says he dug seventy-five pounds of root. Many of the roots would measure an inch in diameter, and a few were two inches in diameter. He transplanted some small roots in a garden in Topeka. These roots grew very rapidly.

In the summer of 1892, the students of the pharmacy school of the Kansas University collected and dried 150 pounds of the root from the fields around and about Lawrence, but these roots were none of them very large. From our own observations, we are inclined to think that Mr. Baker's views are correct—the plant will thrive under cultivation.

The medicinal quality of echinacea seems to be unique. The last edition of King's American Dispensatory devoted about seven pages to the description of the drug, its medicinal properties, etc. This authority states: "Under the older classification of remedies, echi-

nacea would probably be classed as an antiseptic and alterative. Strictly speaking, it is practically impossible to classify an agent like echinacea by applying to it one or two words to indicate its virtues. If any single statement was to be made concerning the virtues of echinacea, it would read something like this: 'A corrector of the depravation of the body fluids,' and even this does not sufficiently cover the ground. Its extraordinary powers—combining essentially what was formerly included under the terms antiseptic, anti-fermentative, and antizymotic—are well shown in its power over changes produced in the fluids of the body, whether from internal causes or from external introductions. The changes may be manifested in a disturbed balance of the fluids, resulting in such tissue alterations as are exhibited in boils, carbuncles, abscesses, or cellular or glandular inflammations. Such changes, whether they be septic or of devitalized, morbid accumulations, or alterations in the fluids themselves, appear to have met their antagonist in echinacea."

One authority, in speaking of the value of the drug in eczema, states: "Many physicians have treated these conditions as a local skin disease. This is a great mistake. Preparations of echinacea, taken internally, have clearly demonstrated its value as an internal remedy in all eczematous conditions."

It is hoped that the experiments of the agricultural department will result in a better knowledge of the habits of the plant and in practical suggestions for its cultivation.